NASA/FAA Grand Challenge Overview

Starr Ginn UAM Grand Challenge Lead

VFS Electric VTOL Symposium

23 Jan 2020

Potential NASA UAM Ecosystem Partnership Approach

NASA intends to establish partnerships with government, industry, and academia to collaborate on the critical enabling technologies and vital research relevant to UAM.

Project Research Partnerships

NASA/FAA Executive Board ("Research Transition Team")

Vehicle Partners

Airspace Partners

Academia

Grand Challenge Series

A major enabler to inform the UAM Ecosystem

Scaled Urban Demo

Community Outcome

UML-4 Book of Requirements

Ecosystem-wide partnerships are required to enable UML-4

UAM Community Integration Partnerships

Professional Associations and Standards

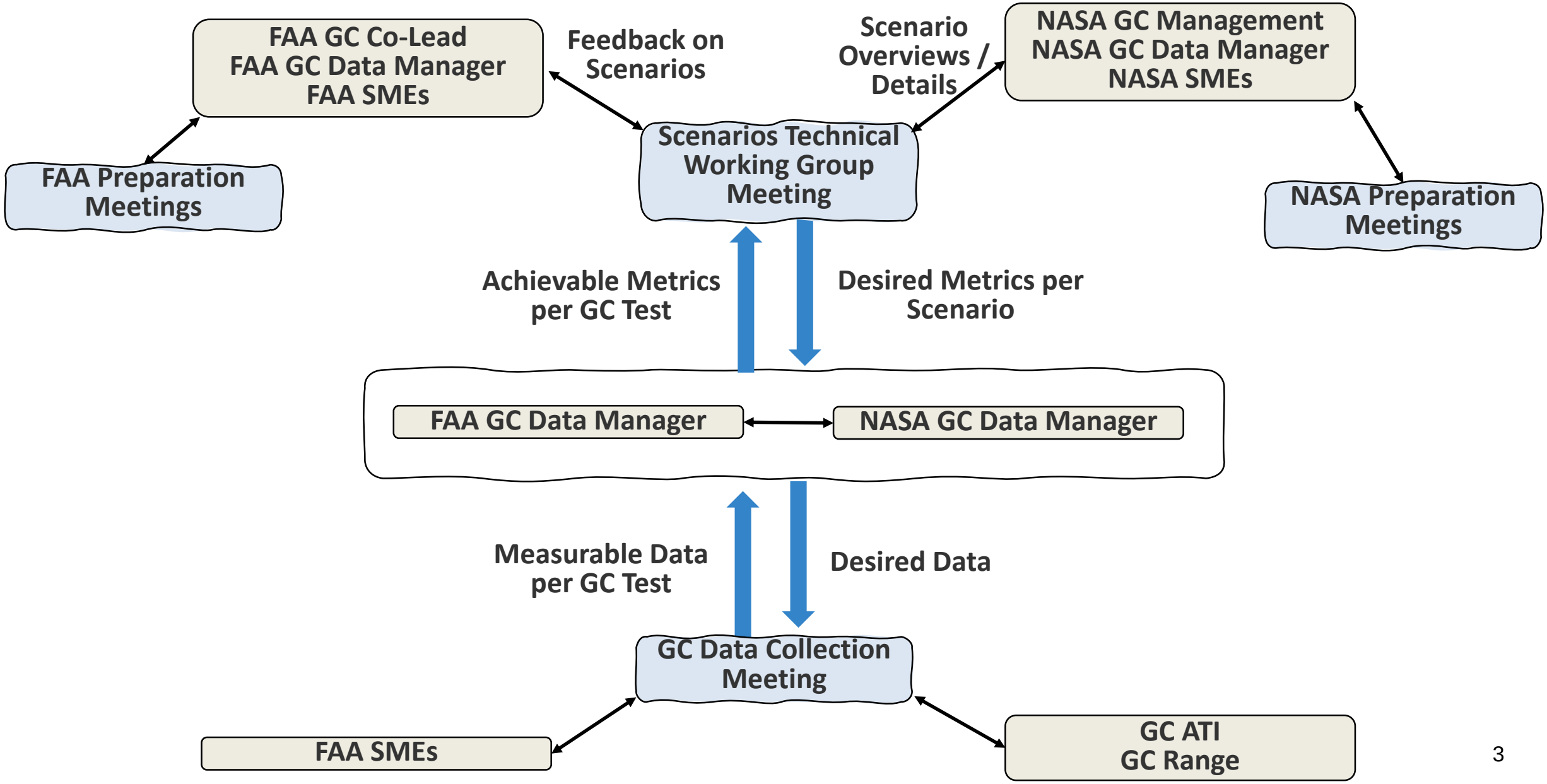
Other Gov't Agencies

State / Local

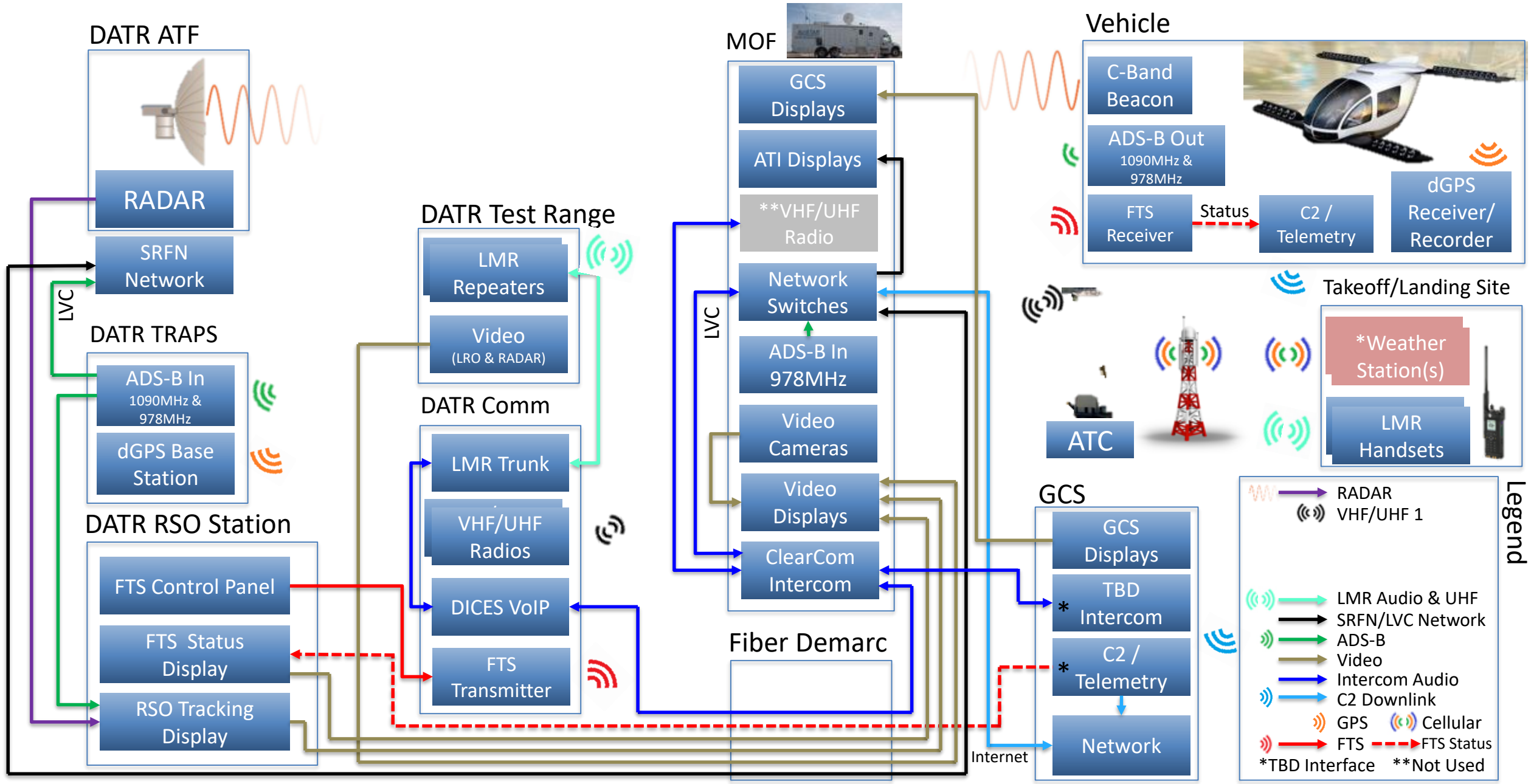
International

NASA plans to partner with Federal/State/Local authorities as well as international & professional associations to develop the policies, regulations, and standards necessary to enable the UAM market.

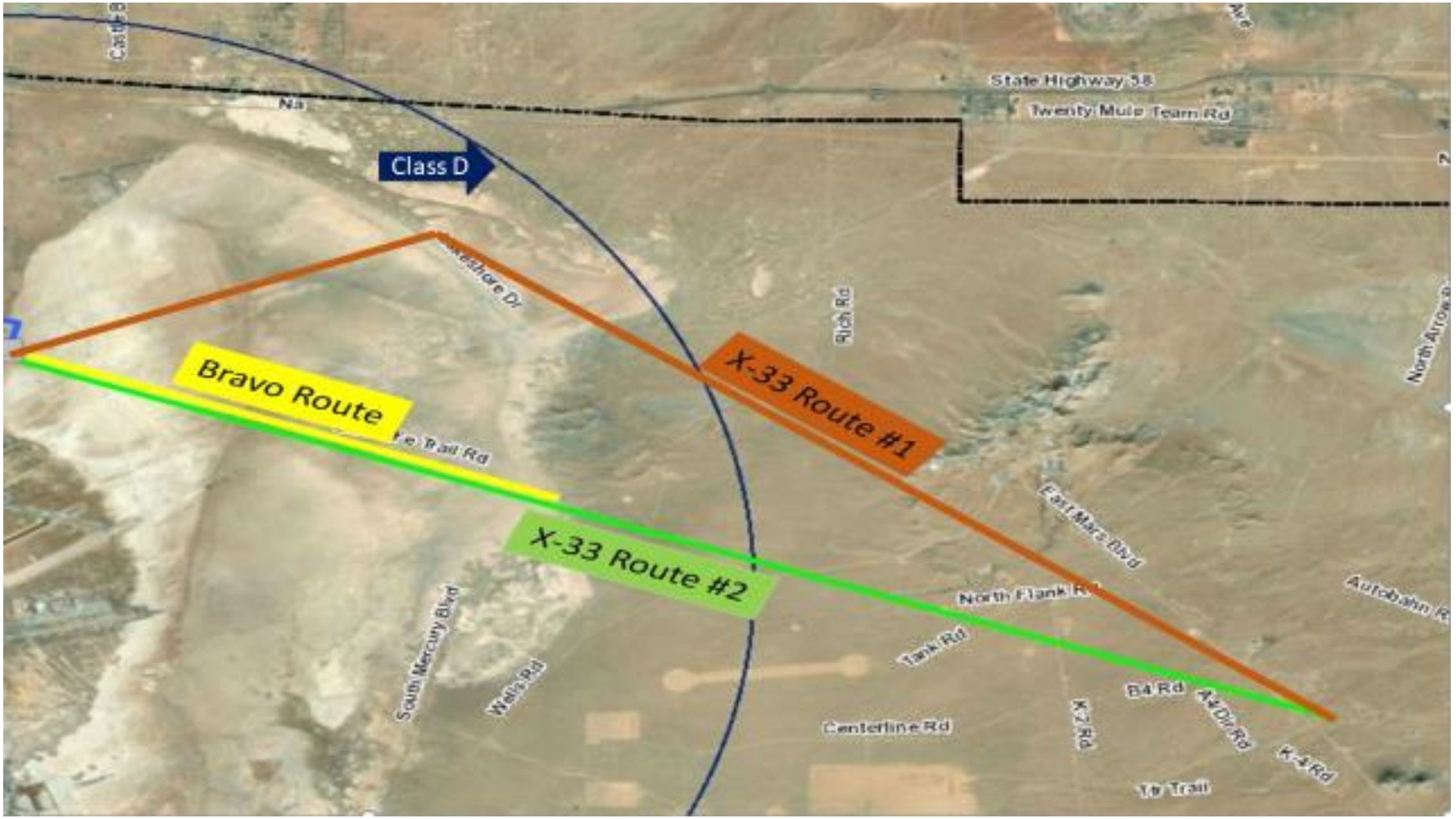
Roles of the Scenarios Technical Working Group: Data Collection



Range Systems - Remotely Piloted Vehicle



Area A to X-33 Route

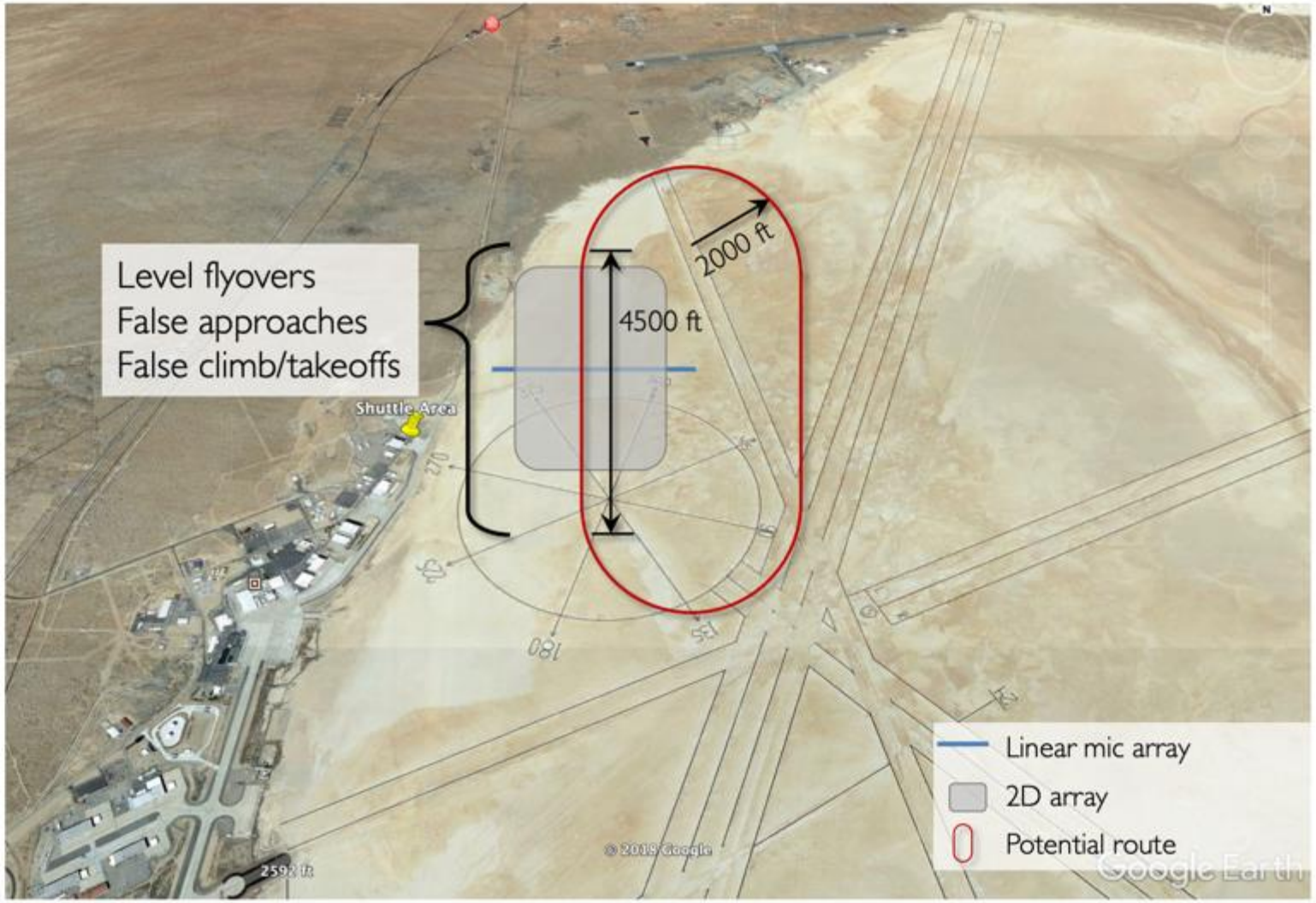


RVLT Edwards Site Planning

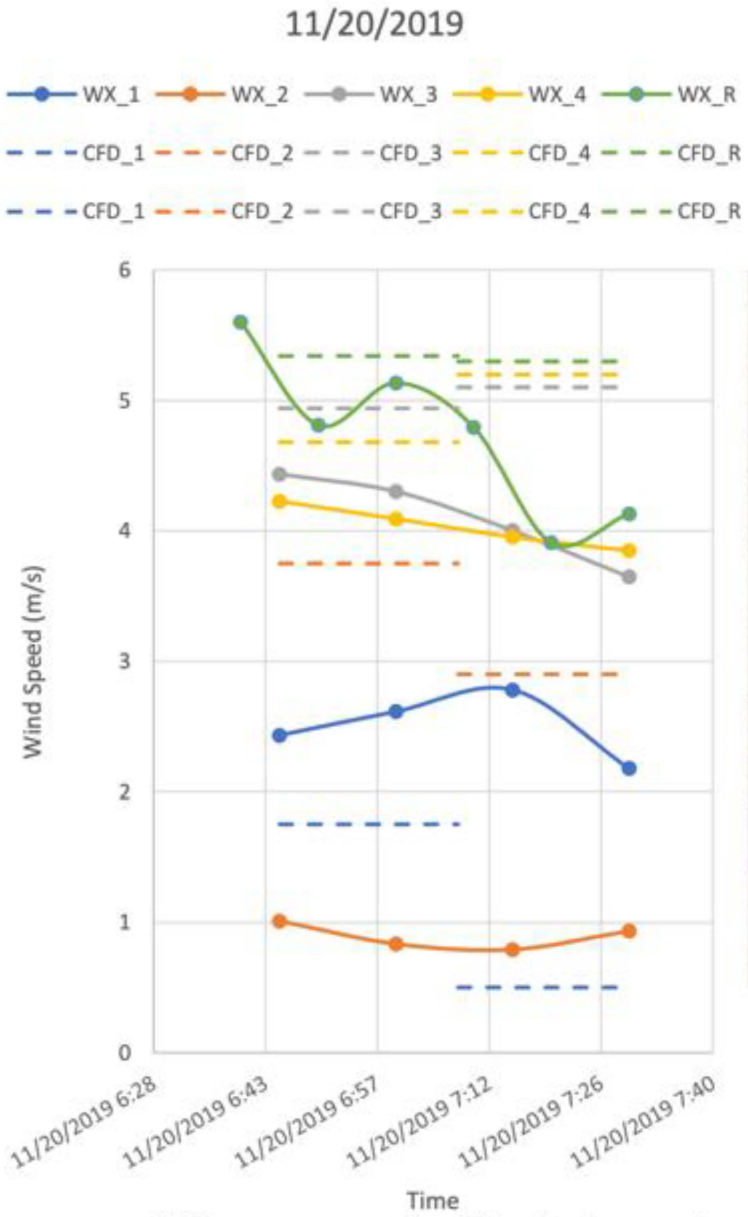
Potential flight routes

National Aeronautics and Space Administration

- Rough route estimate based on conventional helicopter capabilities
- Depending on vehicle capabilities, approach and takeoff tested along level flyover flight path
- Surrounding area needs to be quiet!
- Proposing weekend testing

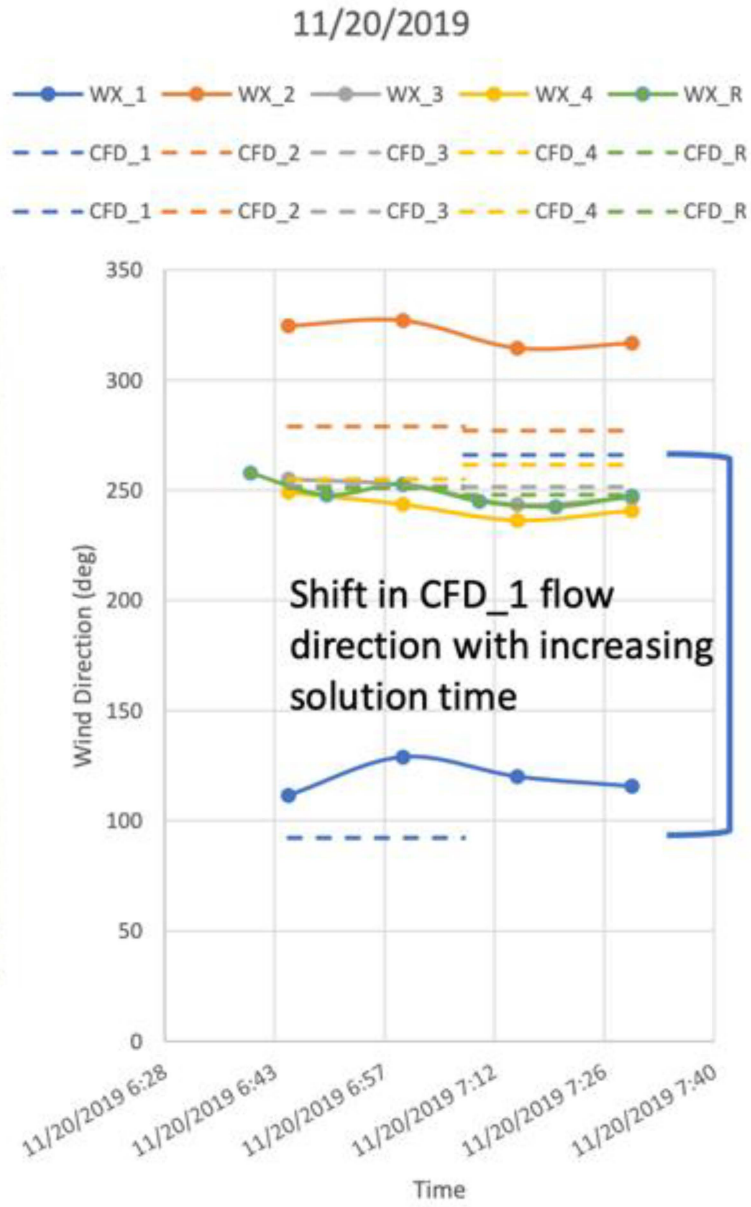


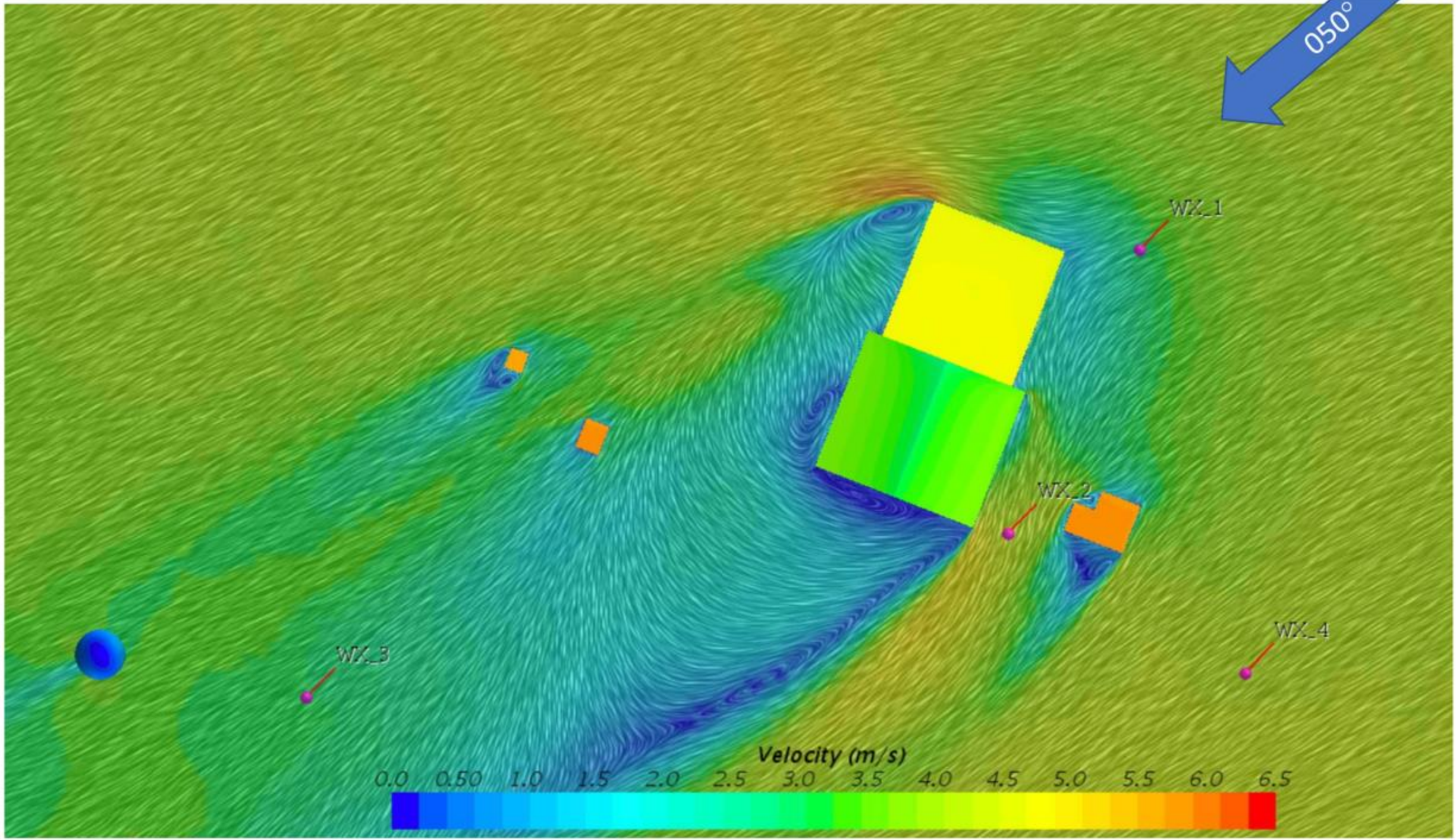
November 20 @ 7:08Z WX Station Surface Data



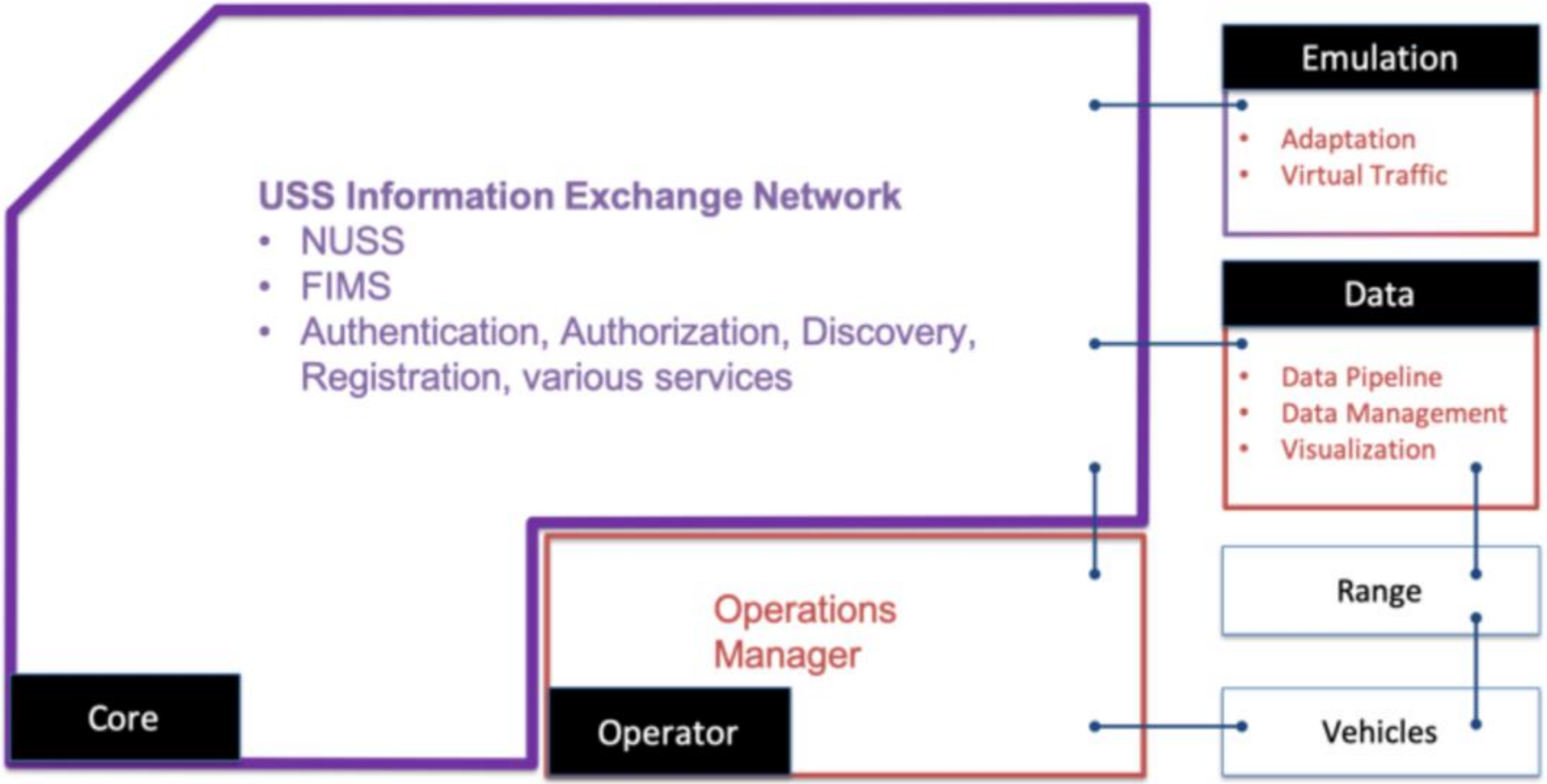
Fair agreement with windspeeds

Left half dashed lines < 500k iters
Right half dashed lines > 500k iters




050°
WX_1
WX_2
WX_3
WX_4
Velocity (m/s)
0.0 0.50 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5

ATI/ATM-X Airspace Operation Manager (AOM)



Data Visualization

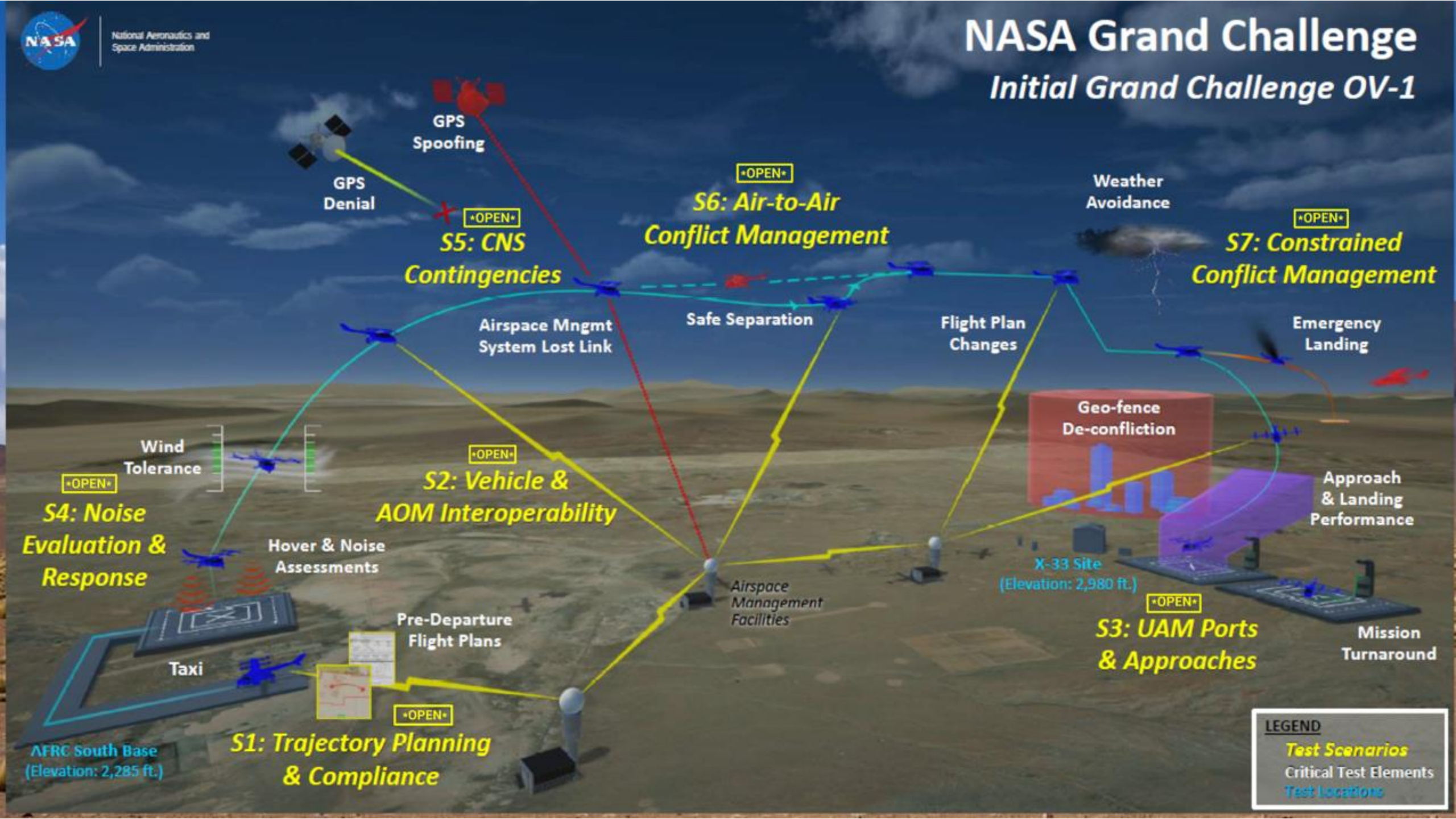
- Grafana dashboard
- Google earth
- iUTM

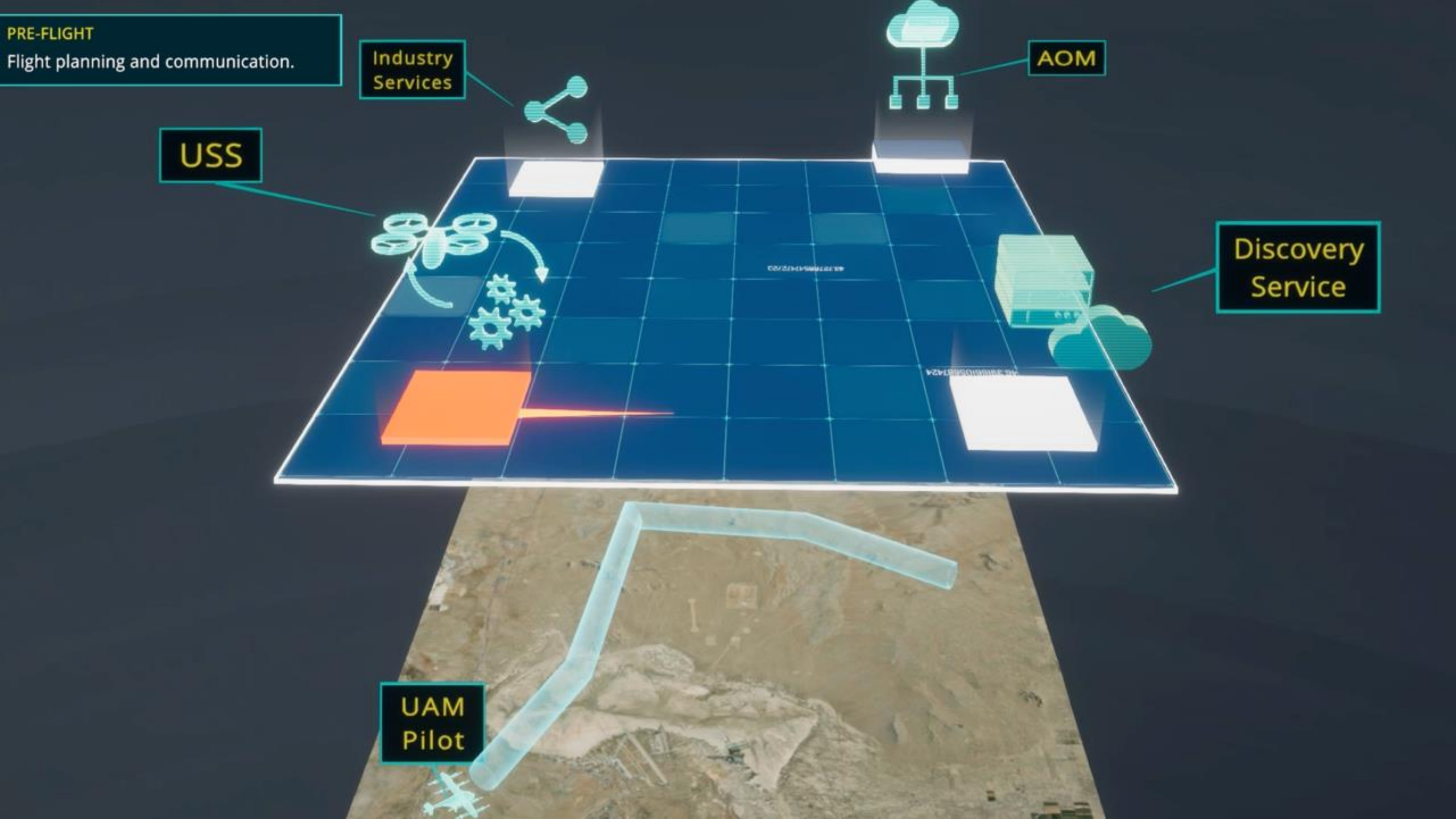
GC DT Flight Test – Scenario 3

	Description	Airspace Assumptions	ATC Interaction	Background Traffic
Scenario 3	Manned vehicles will fly from Area A to X-33 site Unmanned vehicles without a FTS will fly from Area A to X-33 site if two GCS are available (beyond line of sight) Unmanned vehicles with FTS will fly from Area A to Area A Emulate off nominal conditions during UAM port approaches and landings in Class D airspace and the associated interactions with UAM operators (USSs) and ATM along with the associated timing of messages and interactions Scenario 3a: Go Around • Emulate occupied or obstructed vertipad that requires the UAM vehicle complete a go around and enter a loiter pattern • USS provides a consistent off nominal approach as part of initial predeparture flight plan submission Scenario 3b: UAM vehicle divert to a runway • Emulate an emergency landing that requires priority sequencing and diversion to alternate landing location • Vehicle requires a runway landing due to limitations in controllability with given power conditions • UAM operator and vehicle will initiate interaction with ATC in Class D to obtain clearance for landing • The handoff and interactions between UAM operator, vehicle, and ATC need to be defined • Emulated environmental conditions require a balked landing to be executed	Class D and Class G Day VFR UAM corridor has been established and is in use based on a helicopter-like Letter of Agreement (LOA) o Allows for multiple UAM flights in the corridor o No 2 way VHF/UHF communication required in nominal ops o UAM operator will resequence vehicle performing a go around into stream of virtual traffic	3a: ATC Interaction not required 3b: ATC interaction required with vehicle and UAM operator	IFR, GA, and UAM virtual traffic. The IFR and GA traffic will emulate a Class D airport and the UAM virtual traffic will follow route and adjacent routes following a static schedule

Airspace Network

Elements	Services	AOM Component	Minimal Information Requirements
Balked landing	•USS discovery •Operational plan negotiation •Flight position updates •ATC clearance •State maintenance •Conformance monitoring	NUSS FIMS	•Operational state notifications (Cancel) •Operational boundaries •Aircraft position •Flight plans •Static and dynamic constraints •Terrain and weather •


National Aeronautics and Space Administration
NASA Grand Challenge
Initial Grand Challenge OV-1
GPS Spoofing
GPS Denial
•OPEN•
S5: CNS Contingencies
•OPEN•
S6: Air-to-Air Conflict Management
Weather Avoidance
•OPEN•
S7: Constrained Conflict Management
Airspace Mngmt System Lost Link
Safe Separation
Flight Plan Changes
Emergency Landing
Geo-fence De-confliction
Wind Tolerance
•OPEN•
S4: Noise Evaluation & Response
•OPEN•
S2: Vehicle & AOM Interoperability
Approach & Landing Performance
Hover & Noise Assessments
Airspace Management Facilities
X-33 Site (Elevation: 2,980 ft.)
•OPEN•
S3: UAM Ports & Approaches
Pre-Departure Flight Plans
Taxi
Mission Turnaround
•OPEN•
S1: Trajectory Planning & Compliance
AFRC South Base (Elevation: 2,285 ft.)
LEGEND
Test Scenarios
Critical Test Elements
Test Locations

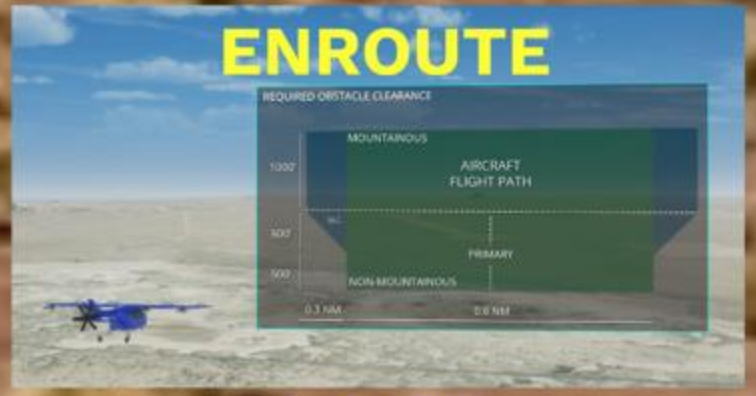

PRE-FLIGHT
Flight planning and communication.
Industry Services
AOM
USS
Discovery Service
UAM Pilot

Scenario 3:
UAM Ports and Approaches

OPEN

OPEN

OPEN

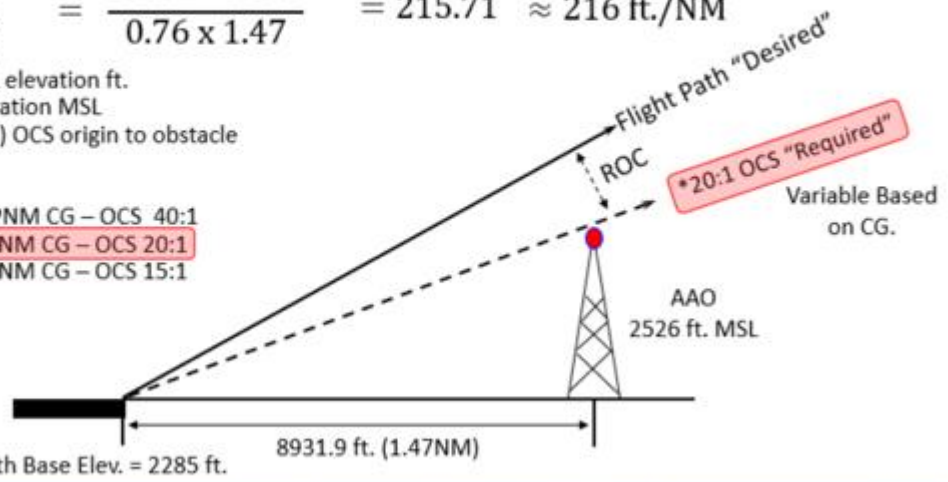


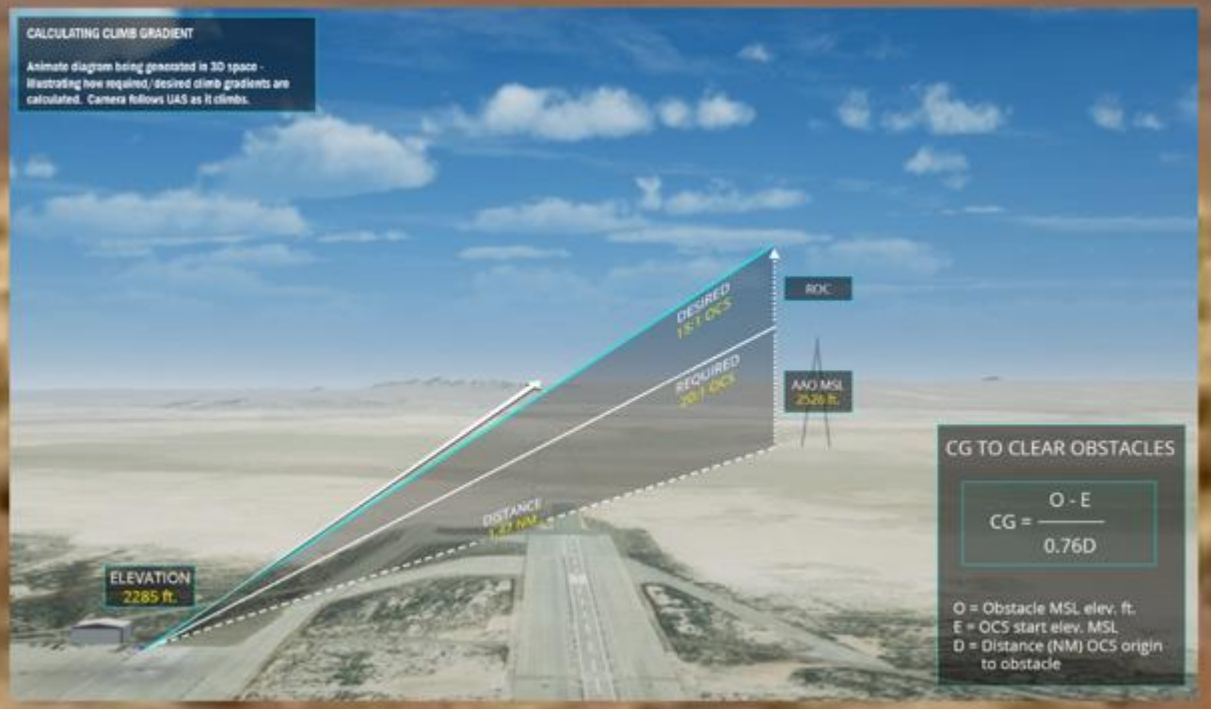
OPEN

$$CG = \frac{O - E}{0.76D} = \frac{2526 - 2285}{0.76 \times 1.47} = 215.71 \approx 216 \text{ ft./NM}$$

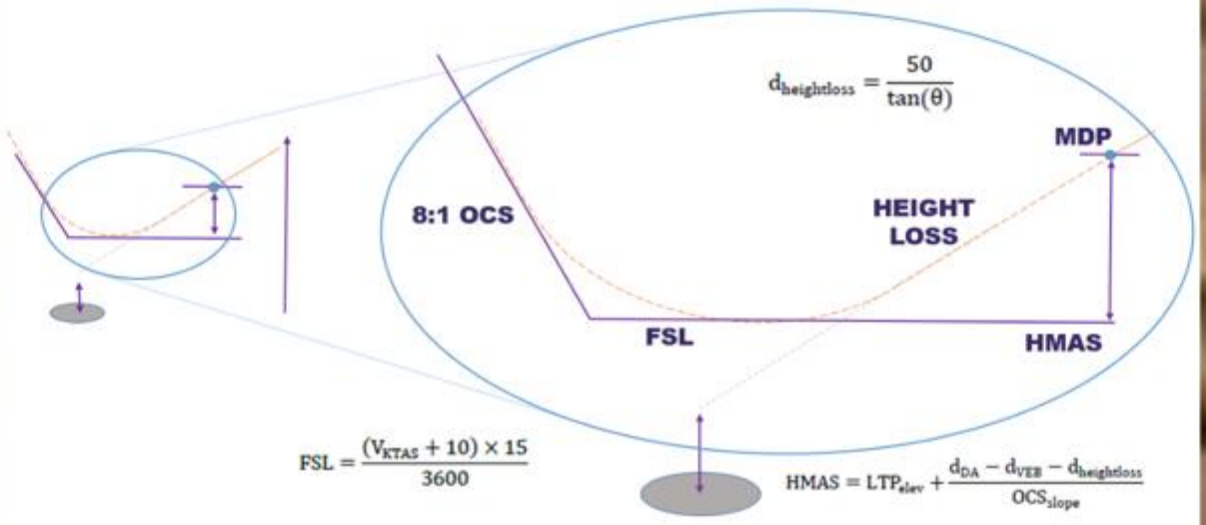
O = Obstacle MSL elevation ft.
E = OCS start elevation MSL
D = Distance (NM) OCS origin to obstacle

*Assumed: 200 FPNM CG – OCS 40:1
300 FPNM CG – OCS 20:1
400 FPNM CG – OCS 15:1

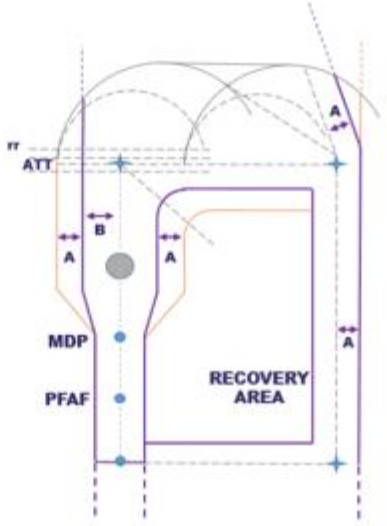


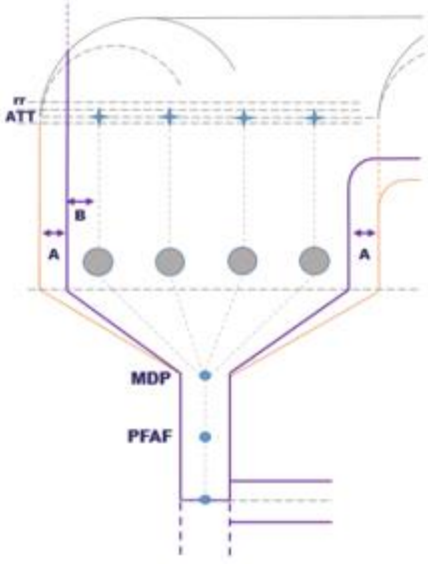


APPROACH DECOUPLING



PROCEDURE RECOVERY





1. **TOLA OEA Operation Agnostic**
2. **Recovery Entry Fix Calculated**
3. **Standard Holding OEA**

A = 1 x XTT
B = 2 x XTT

Grand Challenge Mission Task Elements (MTEs)

Mission Task Elements are discrete test points which we will mix into the Grand Challenge Operational Scenarios

Required Performance:

- Included for NASA's consideration as a minimum entry parameter for safety of flight
- Generally is far less than what will eventually be required for FAA certification

Desired Performance:

- Denotes level of performance that are approaching levels likely* required to gain FAA certification
  - *The FAA has not yet decided on applicable regulations nor minimum design standards for this emerging class of aircraft
- Similar performance level to conventional fixed or rotary wing aircraft

All Azimuth
Taxi
Takeoff Performance
Level Flight Decel/Accel
Flight Path ChangesSteep Turns, Pull Up, Push Over
Approach/Landing
Land-Quick Charge-TO
Energy Storage/Reserves
Function & Reliability
Precautionary landing
Balked Landing
Takeoff Failure Case
Landing Failure Case

MTEs are designed to shed light on operational challenges that will drive future acceptable certification standards